



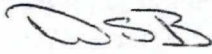
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
NATIONAL RISK MANAGEMENT RESEARCH LABORATORY  
SUBSURFACE PROTECTION AND REMEDIATION DIVISION  
P.O. BOX 1198 • ADA, OK 74820

July 9, 1998

OFFICE OF  
RESEARCH AND DEVELOPMENT

MEMORANDUM

SUBJECT: Technical Review Comments on Evaluation of Natural Attenuation at the  
NL Industries, Inc. Superfund Site, Pedricktown, NJ (98-R02-008)

FROM: David S. Burden, Ph.D., Director   
Technology Support Center  
Research Hydrologist

TO: Joe Gowers  
Remedial Project Manager  
U.S. EPA - Region 2

The following comments are in response to your request for technical assistance at the NL Industries, Inc. Superfund Site, Pedricktown, NJ. Specifically, you requested a review on evaluation of the potential for natural attenuation of lead and cadmium in ground water at the site. Special emphasis was placed on identifying additional data which would be needed to effectively evaluate whether monitored natural attenuation of ground-water contamination would be a viable alternative to extraction and treatment of contaminated ground water. The documents reviewed included the *Draft Phase I Ground-Water Evaluation Technical Memorandum at the NL Industries, Inc. Superfund Site, NJ (Memorandum), March, 1998*, by GeoSyntec Consultants, and *Remedial Investigation National Smelting of New Jersey, Inc./NL Industrial, Inc. Site, Pedricktown, New Jersey (RI report), October, 1990*, by O'Brien & Gere Engineers, Inc. The review was conducted by Dr. Jing-Song Chen, a soil scientist for the Dynamac Corporation, an off-site contractor supporting EPA's Technology Support Center in Ada, OK, with my oversight. I have reviewed his comments and concur with them.

GeoSyntec conducted a pre-design ground-water sampling and evaluated the potential of monitored natural attenuation at the site using the sampling results and the historical data. They concluded that "The data obtained to date indicate that ground water is not transporting contaminants off-site. Therefore, ground water is not a link between site-related contaminants and off-site receptors. (page 20)" and "The effectiveness of natural attenuation at removing contaminants from the ground water at the site has been preliminarily demonstrated by the decrease in the concentrations of site contaminants with no significant migration of the contaminants. (page 27)" and recommended that "future action be directed at confirming that the contaminants in ground water continue to naturally attenuate (page 27)".

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Note that lead and cadmium are the metals considered in this review. Other metals/VOCs will not be discussed since either the concentrations of these contaminants were below Remedial Action Objectives (RAO) or they exist in insignificant amounts and pose little risk to human/environmental health.

## General Comments

While the conclusions and recommendations made by GeoSyntex appear to be reasonable, it is too early to draw the conclusion that effective natural attenuation of lead and cadmium is occurring at the site without further examining the geochemistry data, and fully characterizing site hydrogeology and the attenuation mechanisms. Geosyntex's conclusion was based on the historical and current ground-water monitoring data (dissolved and total metals). Limited geochemistry data have been collected so far at the site. The attenuation mechanisms/pathways were demonstrated but supporting evidence was lacking or not presented. Mere observation of decreasing metal concentrations in ground water does not warrant that the total mass (precipitated/sorbed plus total amount of metals in ground water) of metals is not migrating at a site where complex dynamic processes are occurring.

Additional steps that should be considered include:

- 1) Further site characterization: determination of the mass distribution of metals that are dissolved, precipitated/suspended from solution, or precipitated/coated on the aquifer matrix. This data should be taken both over selected space (areal and vertical) and time. This should be done on vertical core samples when installation of new monitoring wells is planned. Also, more detailed hydrogeology data (flow directions and velocity) are needed.
- 2) Evaluation of the natural capacity of the aquifer material to attenuate the contaminant metal (including study of sorption capacity, cation exchange capacity, and leachability, at various pHs);
- 3) Conducting hydrogeochemical transport modeling: modeling could be performed using parameters estimated from the existing data or reported values in literature (e.g. estimated attenuation rates);
- 4) Long-term ground-water monitoring to verify that natural attenuation is controlling plume migration and that human health and the environment are not adversely affected.

These further steps are required to assure the efficacy of monitored natural attenuation. In addition, hydrological studies including surface runoff and sediment transport of contaminants to surrounding creeks might also be considered.

Equally important, continuous institutional control/excavation of contaminated soils are suggested a) to decrease/eliminate contaminant sources, b) to avoid the pH decrease (i.e. become



acid) in ground water, and c) to stop leaching (e.g. due to acid rainwater) of contaminants through soils to the ground water.

## Specific Comments

### Hydrogeology

Localized variation in flow direction has been reported in both *Memorandum* and *RI* report. In the *Memorandum* (1998), the general directions of ground-water flow within the unconfined aquifer and the first confined aquifer were found to be to the northwest, while flow to the northeast was found in the second confined aquifer. In the *RI* report (1990), the ground-water flow within the unconfined aquifer was reported to be in a northwest direction while flow in the first confined aquifer was in a westerly direction and flow in the second confined aquifer was in an easterly direction. Also, it was reported that the industrial supply wells near the site might be controlling ground-water flow in the second confined aquifer under the site.

There are several controversial statements in the document. In the *Memorandum*, it states that "the general direction of ground-water flow within the first confined aquifer is to the northwest and is consistent with previous findings as reported in the *RI* (O'Brien & Gere, 1990)." (page 8). Further, it is stated that "the general direction of ground-water flow within the second confined aquifer is to the northwest and is consistent with previous findings as reported in the *RI* (O'Brien & Gere, 1990)." These statements are not true (see above paragraph). The *RI* report indicated that the flow directions were in a westerly direction and in an easterly direction respectively.

The impact of ground-water flow on contaminant migration is not thoroughly addressed. Furthermore, the role of ground-water flow in the migration of metal contaminants is not discussed in the *Memorandum*. In the *RI* report, ground-water flow velocities were reported ranging from 0.03 to 2.02 ft/day (1990). The downward vertical flow has been reported in both *Memorandum* and *RI* report, but the magnitudes are unknown. The *RI* report (O'Brien & Gere, 1990) indicated that 1) fluctuations in ground-water elevations appeared to be associated with rain events and ground-water withdrawal on adjacent industrial properties; 2) the unconfined aquifer wells respond very rapidly to direct infiltration from the surface. These facts suggest that further characterization in hydrogeology (flow velocity, localized flow variation, and temporal variation in flow direction etc.) are needed. The ground-water flow might play an important role in contaminant transport.

### Trend Analysis

The statements "... ground water is not transporting contaminants off-site (1st paragraph, page 20)", and "The data indicate that lead is not migrating from the site." (bottom paragraph, *Memorandum*) are not necessarily true because:



- 1) While the ground-water quality trends show that the concentrations of the chemicals of concern across the site have decreased sharply at many sampling points (page 20, Figs. A-G, and Figs. E-1 and E-2, *Memorandum*), this is not true for the downgradient wells 11, 17, 4R, and 1R where the concentrations of lead were increasing after 1983;
- 2) The trend slopes at Wells HS, SD, and KS, where they are close to the center of plume, are much greater (~3 to 10 times) than the trend slopes for Wells BR, JD, 11, MS (where they are much farther away from the center of plume);
- 3) The pHs at most of the monitoring wells have generally increased since 1983. The pH increase in ground water over time might have caused precipitation of lead from ground water. As a result, the concentrations of lead in ground water decreased accordingly over time, but the mass of lead in aquifer material (either in sorbed or precipitated forms) does not necessarily decrease with time;
- 4) Removal of contaminant sources (slag piles etc) occurred between 1990 and 1997. This removal activity cut off the contaminant source, but contaminant migration did not necessarily cease.

In other words, lead migration in ground water is a dynamic process. At this site, decreases in the concentration of lead in ground water over time might be due to removal of sources, pH changes, and other mechanisms. The pH increases might be due to removal of acid sources, natural attenuation (neutralization by aquifer materials such as limestones), etc. It appears to be too early to draw the conclusion that "the lead is not migrating from the site" and "The effectiveness of natural attenuation at removing contaminants from the ground water at the site has been preliminarily demonstrated ..." since understanding of the fate and pathways of lead in the subsurface at this site is minimal. Similar arguments are also true for cadmium. The direct evidence of metal migration is the temporal changes of mass (sum of amounts in dissolved phase in ground water, sorbed/precipitated phases in suspended solids and in aquifer matrix) in three-dimensional space.

#### Geochemical Information about Metals at the Site

Limited geochemical data have been acquired at the site. The results of chemical analysis of ground water (e.g. pH, Eh, sulfates, DO, metals concentrations etc.) are available but other geochemical data such as the sorption capacity and ion exchange capacity of the aquifer matrix for metals, buffer capacity to pH change are not available. Furthermore, mass (sum of amounts in dissolved phase in ground water, sorbed/precipitated phases in suspended solids and in aquifer matrix) in three-dimensional space of metals in the aquifer has not been measured.

To date, little is known concerning the attenuation mechanisms (e.g. precipitation, oxidation/reduction, complexation etc.) at the site. The existing data appear to indicate that dissolution due to pH change plays an important role. For example, dissolved lead concentrations



at wells with low pH (Wells SD and HS with pH 2.9, 3.6 respectively, 1997) are much closer to total lead concentrations in ground water than at wells with higher pH (Wells MS, LS, LD with pH 5.8, 5.5, 4.5 respectively). Obviously, a good understanding of the complex dynamic hydrogeochemical processes of metals at the site is essential to determine if monitored natural attenuation is a viable remedial option at the site.

Therefore, it would be beneficial to collect the necessary geochemical data and conduct a geochemical analysis on geochemical data. For example, the partitioning of lead in different phases could be examined by conducting speciation analysis of lead in ground water using the existing chemical analysis data. Further hydrogeochemical transport modeling would assist in the understanding of attenuation mechanisms and the extent to which contaminant plumes will ultimately migrate when further characterization in hydrogeology and additional geochemistry and monitoring results become available. Batch sorption/precipitation data for lead, and pH titration curves of aquifer materials in ground water would be easy to obtain and very valuable to help understand the dynamic processes of lead in the aquifer.

These comments are offered to you for your consideration. If you have any questions concerning these comments and would like to discuss them with us, please contact me at your convenience by telephone at 580-436-8606 or by email at [burden.david@epamail.epa.gov](mailto:burden.david@epamail.epa.gov).

cc: Alison Hess (C) - Region 2  
Ruth Izraeli (C) - Region 2  
Linda C. Ross (C) - Region 2  
Jon Josephs (290-BRD) - Region 2  
Rich Steimle (5102G) - HQ  
Betsy Shaw (5202G) - HQ





## UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 2  
290 BROADWAY  
NEW YORK, NY 10007-1866

May 5, 1998

Dr. David Burden  
U.S. EPA  
Robert S. Kerr Laboratory  
P.O. Box 1198  
Ada, Oklahoma 74820-1198

Re: Evaluation of Natural Attenuation Potential of Lead and Cadmium in Groundwater  
NL Industries, Inc. Superfund Site, Pedricktown, Salem County, New Jersey

Dear Dr. Burden:

As discussed during our May 5, 1998 telephone conversation, the U.S. Environmental Protection Agency's (EPA's) Region II office is requesting your assistance in the evaluation of the potential for natural attenuation of lead and cadmium in groundwater at the NL Industries, Inc. Site (Site), located in Pedricktown, New Jersey. Specifically, we are interested in identifying additional data which would be needed to effectively evaluate whether monitored natural attenuation of groundwater contamination would be a viable alternative to extraction and treatment of contaminated groundwater.

From 1972 to 1984, NL Industries and National Smelting of New Jersey (NSNJ) operated a secondary lead smelter at the Site. As part of operations at the Site, batteries were drained of sulfuric acid, crushed and then processed for lead recovery at the smelting facility. When the Site was abandoned by NSNJ in 1984, lead slag piles and other lead-bearing materials were left on Site. In September 1991, EPA signed the Operable Unit Two (OU2) Record of Decision (ROD), which selected a remedy for remediation of the slag as well as contaminated buildings and surfaces. In November 1992 a group of potentially responsible parties (PRPs) initiated the OU2 remedy. As part of this remedy, slag was disposed of off Site, lead oxide piles and other lead-bearing materials were sent to a secondary lead smelter for recycling, and on-Site buildings were dismantled. In July 1994, EPA signed a ROD for Operable Unit One (OU1). The OU1 ROD called for excavation of contaminated soil and sediments, and for extraction and treatment of contaminated groundwater. The OU1 remedy is currently being designed by the PRPs' consultant.

Pre-design activities for the OU1 remedy included the collection and analysis of groundwater samples from select monitoring wells at the Site. Based upon the results of this limited sampling round, the PRPs' consultant has recommended that monitored natural attenuation be implemented in lieu of active groundwater remediation at the Site. The results of the pre-design groundwater sampling event as well as the PRPs' recommendation are provided in the enclosed "Draft Phase I Ground-Water Evaluation Technical Memorandum" (Ground-Water Evaluation). In addition, historic groundwater quality data are provided in the enclosed "Remedial Investigation of the NL Industries, Inc. Site".

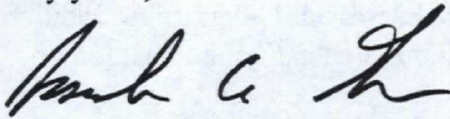


As indicated in the November 1997 EPA document entitled, "Use of Monitored Natural Attenuation At Superfund, RCRA Corrective Action, And Underground Storage Tank Sites", understanding the specific mechanism responsible for attenuation of the inorganic contaminants is important in the evaluation of natural attenuation, as some mechanisms are more reversible than others. Therefore, verifying the existence and demonstrating the irreversibility of these mechanisms are key components of a protective monitored natural attenuation remedy. At present, EPA Region II does not believe that the PRPs' consultant has satisfied these requirements.

EPA Region II therefore requests that you arrange for the review of the Ground-Water Evaluation by appropriate staff to determine additional data needed to effectively evaluate the viability of monitored natural attenuation of groundwater contamination at the Site. Please submit any comments or recommendations which you may have by June 28, 1998.

If you have any questions regarding this request, please feel free to contact me at (212)637-4413. Thank you for your assistance.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Joseph A. Gowers". The signature is fluid and cursive, with the first name being the most prominent.

Joseph A. Gowers, Project Manager  
Southern New Jersey Remediation Section

Enclosures